g the last several years, many scientists have
zed the world around us to unravel the complex
of interconnections that characterize seemingly
social [1], biological [2, 3] and technological sys-
5]. These systems have been shown to exhibit
features that can be captured using the tools of
heory or in more recent terms, network modeling.
ame time, network models of diverse kinds have
oposed with the aim of describing and explaining
perties of real webs [6, 7]. It turns out that most
works are better described by growing models in
e number of nodes (or elements) forming the net
s with time and that the probability that a given
s k connections to other nodes follows a power-
$\sim k^{-\gamma}$, with $\gamma \leq 3$. Additionally, the study of
s taking place on top of these networks has led
consider classical results obtained for regular lat-
random graphs due to the radical changes of the
dynamics when the heterogeneity of complex
s can not be neglected [8, 9, 10, 11].

first scale-free network model, introduced by
i and Albert (BA), postulated that there are two
ental ingredients of many real networks [12, 13]:
owing character and the preferential attachment

arbitrary γ-exponents, and non-random correla
be found nowadays in the scientific literature.
other hand, there are some models in which the l
limited to a neighborhood due to geographic co
[14], or where its linear character is investigated
cently, Caldarelli *et al.* [16] have shown that
produce SF networks without assuming prefer
tachment at all. As a byproduct, other propert
network fit well with those of real-world graph
introduced an intrinsic fitness model in which t
are connected with a probability that depends
fitness. Note, additionally, that the way in w
fitness parameter was introduced is different
model in [17].

In this paper, we adopt a different perspect
aim is to test to what extend the global charac
PA rule in the original BA model is important.
duce a model in which the PA is applied only to
borhood of the newly added node depending on
of a variable which measures the affinity betwe
ent nodes. By going down from the BA limit of t
to the the limit where all nodes are distinct, w
what extend the global knowledge of each node'
tivity is fundamental to get a scale-free graph.

$$\Pi(k_i) = \frac{k_i}{\sum_{s \in A} k_s} \qquad (1)$$

ally v) Repeat steps ii-iv such that the final size
network is $N = m_o + t$.

after t time steps a network made up of N nodes
. It is worth mentioning that the inclusion of the
arameter a is not a mere artifact. Indeed, most
ms are formed by non-identical elements and
natural to assume that although a given node
ve a large connectivity a newly created element
link to that node because they have very little
on. This feature is clearly manifested in social
like the WWW −where individuals bookmark
web pages accordingly to their "affinity"− or
ntist citation network [19]. In this way, it is very
to find a citation in a condensed matter paper
to a paper wrote by a psychologist. Addition-
same argument can be translated to biological
such as predator-prey webs or protein-protein
on networks.

sly, when μ is large enough as to dilute the first
the model, we recover the BA model. The prob-
consists of determining to what extend the lo-
rential attachment will give the same results, or
words, does the knowledge of the entire network
ally contribute to the properties observed in the

FIG. 1: Number of nodes with connectivity k for
values of μ. The size of the network is $N = 10^4$
$m_o = m = 3$. The power-law distribution has an
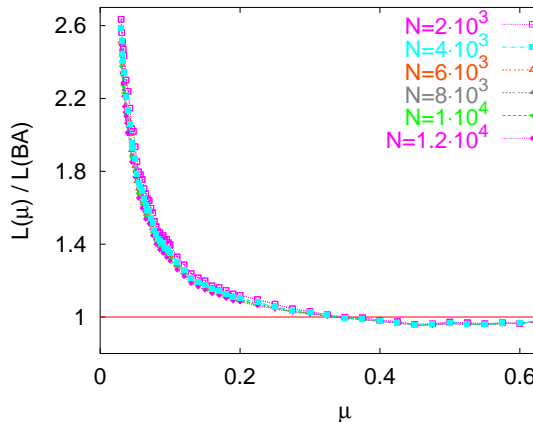equal to 3. Note that the BA limit corresponds to

FIG. 2: Ratio between the average shortest path
different μ values, $L(\mu)$, and that of the BA network
several system sizes. The horizontal line marks the
A transition from graphs fulfilling the small-world p
a regime in which networks break down in many sm
rising the value of $L(\mu)$ is observed. See the text f
details.

work is made up of $N = 500$ nodes.

es, but there is nothing that guarantees a priori... components of the network will link together... a way that other properties will not be affected.... the case of the average shortest path length L.... age shortest path length of a graph is defined as... mum number of nodes one has to pass by to go... node of the network to another randomly chosen... eraged over all possible pairs of nodes. Complex... show the noticeable property, known as small-... property, that the average path length increases... the logarithm of its size. We expect that for... ues of μ the network is composed by a unique... ponent and no fragmentation arises. When... ge to which the affinity criterion is applied de-... the network will gradually loose its compactness... stretch approaching a one-dimensional structure... e small components. Further reduction of μ pro-... e break down of the network in many isolated...

es 2 and 3 substantiate this picture. Figure 2... ts the ratio between the average path length ob-... or different values of μ and that of the BA net-... or several system sizes. As μ restricts the PA... e network undergoes a transition characterized...

efficient c_i. The clustering coefficient of a nod... fined as the ratio between the number of edges... the k_i neighbors of i and its maximum possib... $k_i(k_i-1)/2$, i.e., $c_i = \frac{2e_i}{k_i(k_i-1)}$. In this way, th... clustering coefficient, c is given by the average... all nodes of the network. The clustering coeffic... local character as it gives the probability that t... with a common neighbor are also linked togeth... it is expected that this magnitude, in our model... on the affinity of each node and the range of pr... attachment given by μ. Figure 4 shows the ave... tering coefficient of nodes with a given conne... for different values of the parameter μ. The... exhibits almost no correlations with the degre... vertices and the smallest value for the clusteri... cient. As μ is reduced, the first selection of node... affinity values plays a more dominant role cor... to the rising of c_i for small and large connectivit... the transition, $\mu \sim 0.04$, the average coefficient... one order of magnitude greater than that of the...

FIG. ... Average nearest neighbor connectivity k_{nn} against k
... al values of μ. Results are averaged over 100 network
... ns for each μ value. Other parameters are as of fig.

... he tendency that networks generated with small
... f μ display disassortative mixing at both ends of
... ectivity range.

... paper, we have studied a version of the Barabási
... ert scale-free model that allows to tune the range
... n the preferential attachment is applied. The
... onsiders that all nodes are different such that they
... rinciple unable to link to very distinct nodes. By
... ing an affinity selection before applying the pref-
... attachment rule, we tested whether or not the
... ge of the entire network is an essential requisite
... cale-free networks. Our results seem to support
... that having at least some degree of preferential

where non-trivial properties arise. In this sense...
be interesting to perform the same analysis in n...
istic growing network models looking for more si...
with real-world networks. For example, the exp...
the connectivity distribution can be tuned to sm...
by incorporating the first level of selection of th...
model in the generalized BA model [6], which ...
to give arbitrary γ values in the interval $(2,3)$.

Acknowledgments

. E. J. Newman, Proc. Natl. Acad. Sci. U.S.A. **98**, 404
1).

. Jeong, S. P. Mason, A.-L. Barabási, and Z. N. Oltvai,
ure (London) **411**, 41 (2001).

. V. Solé, and J. M. Montoya, Proc. R. Soc. London B
, 2039 (2001).

[11] Y. Moreno, J. B. Gómez, and A. F. Pacheco, P...
E **68**, 035103(R) (2003).

[12] A.-L. Barabási, and R. Albert, Science **286**, 50...

[13] A.-L. Barabási, R. Albert, and H. Jeong, Physi...
173 (1999).

[14] S. Mossa, M. Barthelemy, H. E. Stanley, and ...